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ACCIDENTAL NUCLEAR WAR: REDUCING THE RISKS

by Dianne DeMille

"There is a latent fear, almost an intuitive or folk wisdom belief, . . . that something just has to go wrong in anything that complicated . . . people believe in Murphy's Law."

Paul Bracken
The Command and Control of Nuclear Forces.[1]

In the popular imagination, an accidental nuclear war could be caused by the failure of a microchip, by a radar mistaking a flock of geese for incoming bombers, or by the unauthorized launch of nuclear weapons by a mad submarine captain. Like Murphy, most people believe that any complex machine will, sooner or later, 'go wrong.' Systems like those that control nuclear weapons seem especially likely to go wrong because, to the vagaries of mechanical devices, are added the ever-present possibilities of human error or bureaucratic foul-up.

DEFINING THE PROBLEM

The fear of accidental nuclear war is a broad topic with vague boundaries. Many problems are lumped together under the term. These range from simple technical errors to the miscalculation and unintended escalation which is sometimes referred to as 'inadvertent' nuclear war.

It is true that, in the early 1950s, a flock of geese was mistaken for Russian bombers and in 1960 a radar beam bounding off the moon mimicked a Soviet missile strike. In 1980, the failure of a microchip led to a false alarm at NORAD, the North American Aerospace Defence Command. Obviously none of these simple technical failures led to a launch of US weapons; the errors were detected in time to prevent a catastrophe.

Security analysts worry less about a simple accident and more about the danger posed by a prolonged international crisis. During heightened tensions, when suspicions run high and the emphasis is on rapid response, many inhibitory safeguards are removed. Under such conditions, it is feared that a false alarm or other ambiguous warning might lead to a nuclear war.

Inadvertent war is a more complex concept. It involves human error, misperceptions and miscalculations. World War I is often put forward as an example of a war which came about through compounded misunderstandings. Military mobilization in one country, mounted as a precautionary move to avoid being caught off guard, was interpreted as aggressive by other countries which then mobilized their own forces. The moves and counter-moves seemed to lead, inexorably, to a devastating war.

Another worry of politicians and researchers is the 'third party' scenario. The fear is that the use of nuclear weapons by a smaller nation or by terrorists could trigger a war between the superpowers. This is referred to as a 'catalytic' war.

The purpose of this paper is to explore the issues of 'accidental' and 'inadvertent' nuclear war and to review measures that have been taken, or might be taken in the future, to reduce the risk of catastrophe.

POSITIVE AND NEGATIVE CONTROL OF NUCLEAR FORCES

The following discussion refers to systems belonging to the United States because much more information is publicly available about these weapons than about those of the Soviet Union. For the purposes of this paper, it is assumed that the Soviet Union maintains at least as stringent control over its nuclear forces as does the US.[2]

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Steps taken to prevent the unauthorized use of nuclear weapons — mechanical impediments, electronic locks, restrictive operational procedures — are, collectively, referred to as 'negative control'. An analogy for a system under strict negative control might be a police officer who keeps his gun, unloaded with the safety catch on, securely snapped into his leather holster. Under these circumstances, there is little chance that the officer will discharge the firearm by accident. Similarly, during times of relative calm, there are multiple safeguards in place inhibiting the unauthorized or accidental use of nuclear weapons.

On the other hand, positive control means making sure the weapons actually go when the decision to launch has been taken. Because of the speed of modern ballistic missiles, military planners want to be sure that their own missiles can be launched rapidly. From this it becomes obvious that enhancing positive control means reducing negative control. In addition, the need for speed in the transition from one set of controls to the other causes problems.

An analogy would be a police officer entering a very dangerous and tense situation knowing that an armed adversary is waiting. The officer proceeds with the gun in his hand, loaded and ready to fire. Under the circumstances of intense pressure and apprehension, it is easy to imagine an accidental shooting.

Similary, some researchers are concerned about the danger of accidental nuclear war during a time of international crisis. They fear that decision-makers may find themselves under intense pressure to ease the inhibitory controls and increase the overall 'readiness' of the system.

CONTROLLING STRATEGIC NUCLEAR FORCES

There are several components in the strategic nuclear arsenal of the superpowers: longe-range bombers, submarine-launched ballistic missiles, sea-launched cruise missiles, and intercontinental land-based missiles. In addition to the weapons themselves, there is the network of command and control systems which are designed to detect the first sign of enemy attack and to coordinate a response. Each of these components has unique problems of positive and negative control.

Bombers

To ensure their survival and their ability to reach assigned targets, the strategic bomber force is ordered airborne, or 'scrambled', during a crisis. This is positive control. The aircraft go into a holding pattern; they do not head toward their targets until ordered to do so. Bombers can be recalled when the crisis has subsided, or in the event of a false alarm.

Submarine-launched ballistic missiles

Submarines equipped with nuclear missiles do pose some problems of command and control. These weapons are not equipped with the electronic locks called 'permissive actions links' or PALs. It is theoretically possible for a weapon launch to be initiated by the commanding officer, the weapons officer, and two other officers who have been entrusted with combinations to a safe containing launch codes. There are some inhibitions on an unauthorized launch. The entire ship must be prepared for launch. Preparation includes slowing the ship and taking it down to the appropriate depth for firing. An alarm sounds throughout the ship when a launch is imminent. Still, some analysts have suggested that the missiles on board submarines need to be made even more secure.

Sea-launched cruise missiles

Surface ships carry cruise missiles which can carry nuclear warheads. Some analysts argue that the sea-launched nuclear weapons are the most likely to be used first in a confrontation between the superpowers.[3] Like submarine-launched ballistic missiles, these cruise missiles are not equipped with electronic locks and the autonomy of the naval command and control of these nuclear forces is of concern to many analysts. Again, it has been argued that these weapons need to be made more secure.

Land-based missiles

The strategic land-based intercontinental ballistic missiles (ICBMs) cannot be recalled once they have been launched. However, they are, by virtue of being based on land in fixed silos, more vulnerable to a first strike that are sea-launched systems. It is here where the conflict between positive and negative control is most acute.

These missiles cannot be launched without an electronic code which is entrusted only to the president of the United States. Each cluster of ten ICBMs is controlled by two launch control officers who must turn their keys at the same time to execute their orders; neither acting alone could launch the missiles.

Five of these two-man crews make up a squadron. If one crew attempts to launch their missiles, the four other launch control centres are alerted. The missiles will not be launched unless another team turns their keys within a very short time. Furthermore, any one of the officers in the squadron can inhibit the launch orders given by any single two-man crew.

Command and Control

The early warning system is crucial to US strategic planning. Personnel of the US command and control network constantly monitor information sent back

from satellite-based infrared sensors and ground-based radars. In order to avoid launching nuclear missiles in response to a false alarm, a great deal of redundancy is built into these warning systems. In other words, if one channel for the flow information breaks down, there are other channels available to transmit the same message. In addition, there is a standard procedure which the US military has dubbed 'the doctrine dual phenomenology.' It requires that any warning coming from one family of sensors — space-based heat detectors, for example — must be confirmed by information coming from another family of sensors — the radars. Also required is corroboration from human 'intelligence' such as diplomatic reports, espionage, and the like. The US Department of Defense claims that the redundancy of the system and the requirement for multiple, simultaneous warnings make accidental nuclear war very unlikely.

EUROPEAN THEATRE

US nuclear weapons which are based in Europe present a different set of problems. The short-range tactical nuclear weapons are integrated into the conventional force structure of NATO, and plans for their use are incorporated into the operational procedures for fighting a war in Europe. These tactical weapons, along with the intermediate-range nuclear forces (INF),* belong to the US but are based on the territory of European countries. The joint control of these forces by military personnel from different nations requires stringent control during peacetime. The weapons deployed in Europe are equipped with 'permissive action links' (PALs) which serve as electronic locks. The use of nuclear warheads requires a coded electronic message from the Supreme Headquarters of the Allied Powers in Europe (SHAPE). As long as these codes are withheld the use of nuclear weapons by unauthorized personnel or by terrorist groups is highly unlikely.

DANGER DURING CRISIS

Political and military leaders are aware that strategic nuclear weapons, if they must be used, are most effective in a coordinated attack, implemented according to carefully developed plans, especially if the attack is aimed against military targets.

Strategic analysts and others are concerned about the danger of accidental nuclear war, not during ordinary peacetime conditions, but during a time of crisis. Decision-makers will be under pressure to ease off on negative controls and enhance positive control so that the missiles can be used according to plans, before they and the leaders who command them can be destroyed.

Within the North American Aerospace Defence Command, there is a well-defined sequence of events leading from the point where infrared sensors on US satellites first detect the heat of the booster rockets on Soviet missiles, to the point where the US president gives the command to launch. What follows is a simplified summary of this sequence.

The initial detection by satellite-based sensors is relayed to a station on the ground where the raw data is processed and passed along to a NORAD command post. In response to the warning, officers on duty at the command post evaluate the possible threat in a 'missile display conference.' Even during peacetime these 'non-routine' conferences are called, on average, once every couple of days (153 such conferences were called in 1984), because the Soviet Union and China frequently test-fire their missiles and because there are a variety of natural phenomena such as meteor showers which can produce readings that can trigger a missile display.

If the duty officers become convinced that the warning is not a benign event, such as a test, but represents a genuine threat, they seek further information from other sensors. A second warning coming from the system of radars is taken as a corroboration of the initial detection. A conference of more senior military personnel, including the chairman of the US Joint Chiefs of Staff, is called to assess the threat. This is referred to as a 'threat assessment conference.' It is at this point that the strategic bombers take off as a precautionary step. If the senior personnel determine that the threat is real, they contact the president. In their report, they grade their assessment as having either low confidence or high confidence. This report leads to a third level of conference, the 'missile attack conference,' which involves the senior military personnel and the president. (No such conference has ever been called except during war games.) If the president then decides to launch a retaliatory strike, he gives orders to send the electronic code to the launch control officers waiting underground.

With the advent of ICBMs the entire sequence from first warning to launch has to take place within twenty minutes in order to avoid having the missiles destroyed in their silos. But there is the question whether decision-making under such a restricted time frame can, or will, be 'rational.'

During international crises, US nuclear forces have sometimes been thrown into a higher level of readiness in order to send a political message to the other side. The purpose is to signal resolve. For example, at the end of the 1973 Middle East War a crisis arose when the US became concerned about Soviet involvement in the area. US strategic forces were put on alert. The crisis was resolved when the USSR agreed to send only

*It now appears that these INF weapons will soon be removed from the European theatre since an agreement to dismantle these systems has been negotiated between the US and the USSR.

non-military representatives to observe the ceasefire between Egypt and Israel.

The practice of using nuclear alerts to send a political signal worries some researchers. What would happen if a false alarm came during the heightened tensions of a prolonged international crisis with nuclear forces on alert?

LAUNCH ON WARNING/ LAUNCH UNDER ATTACK

US government spokespersons have argued that fears of accidental nuclear war are largely unfounded because it is US policy to launch only after an attack has been confirmed. This policy is sometimes referred to as 'launch-under-attack.'

Some authors make a clear distinction between launch on warning and launch under attack. Barbara Marsh, while attending the US Naval Postgraduate School, wrote a thesis entitled *The Probability of Accidental Nuclear War* which included definitions for these two policies, gleaned from studying NORAD documents and practices:

> Currently, the United States has a *launch-under-attack* policy. In this thesis, *launch-under-attack* means launching some fraction of the threatened ICBM force when the early warning system confirms a threat and that threat is assessed with *high* confidence.[4] (Emphasis in the original.)

In this case warnings would have been received from two different families of sensors; the senior personnel involved in the 'threat assessment conference' would have decided with high confidence that the threat was real; and the president would then give the command to launch.

On the other hand, Marsh contends:

> *Launch-on-warning* means that upon detecting the launch of an enemy's missiles and confirming the threat at the site (albeit with *low* confidence), we would launch some fraction of the threatened ICBM force before those missiles reached any of their targets.[5] (Emphasis in the original.)

In this case the warning would have come from only one family of sensors and senior military personnel would have met and assessed the threat. Their report to the president would have noted the 'low confidence' proviso and the decision to launch would then be in the hands of the president. The advantage of a launch on warning, according to Marsh, is that it would increase the time for careful assessment, consultation and deliberation. The disadvantage is that it greatly increases the danger of accidental nuclear war.

In other literature dealing with the command and control of nuclear forces, these alternative launch policies are more closely related. Bruce Blair, author of *Strategic Command and Control* and a former launch officer, uses the two terms interchangeably.

John Steinbruner, in his *Scientific American* article entitled "Launch Under Attack," also makes no distinction between the two policies:

> . . . the US might be planning to accompany MX deployment with an increased inclination to launch its ICBMs after acquiring reliable evidence that a Russian attack was under way but before its actual effects were felt. This policy, usually labeled 'launch on warning' or 'launch under attack,' . . .[6]

If there is in truth no operational distinction between the two policies, then perhaps Bruce Blair is right in arguing that the US is currently in a *de facto* launch on warning posture. In any event, this ambiguity needs to be clarified.

USING MODELS TO ASSESS THE RISK

In an attempt to estimate the risk of accidental nuclear war, some investigators have devised mathematical models for the strategic command and control system. In these models, numerical values are assigned to the following factors:

(a) the decision time available;
(b) the flight-time of enemy missiles;
(c) average time required to resolve false alarms;
(d) the frequency of false alarms;

The decision time available is dependent on the flight-time of enemy weapons. When long-range bombers were the primary threat, there was substantial decision time. With the advent of ICBMs capable of travelling between continents in about half an hour, decision time was reduced. New weapons deployed in the early 1980's have reduced decision time even further. The flight-time of a Pershing II missile launched from West Germany against the nearest military targets within the Soviet Union can be set at between 12 and 14 minutes. This is one major reason why the Soviet Union favoured the agreement which will remove these missiles from Europe. The dismantling of these forward-based, highly accurate ballistic missiles will increase warning time and therefore the time allowed for Soviet decision-making.

The average resolution time and the frequency of false alarms can be deduced from NORAD records obtained by the Center for Defense Information under the US Freedom of Information Act. The table below shows that the number of non-routine missile display conferences (MDC) has been increasing since 1977. The lower number in 1984 was the result of NORAD redefining the circumstances for calling such a conference. Note that only six of the much more serious threat assessment conferences (TAC) have been called.

These occurred in 1978, 1979 and 1980. According to public sources a missile attack conference (MAC), which would have involved the president, has never been called.

Table I

NORAD FALSE ALARMS 1977-1984

Year	MDCs	TACs
1977	43	0
1978	70	2
1979	78	2
1980	149	2
1981	186	0
1982	218	0
1983	255	0
1984	153	0

MDC = missile display conference (non-routine)
TAC = threat assessment conference

In a paper entitled "Accidental Nuclear War: A Risk Assessment," Michael Wallace, Brian Crissey and Linn Sennott use the information described above to estimate the percentage of serious false alarms (i.e., those resulting in a threat assessment conference) that would take longer to resolve than the decision time available. They then estimate the probability that such an unresolved false alarm will occur during a time of international crisis. Of course the probability rises as the duration of the crisis rises. The key assumption here is that a serious unresolved false alarm which arrives during a time of high tension could lead to a mistaken launch of nuclear weapons. Their model predicts that, as decision time decreases, the chance of accidental nuclear war during a prolonged international crisis rises dramatically. For example if the decision time is 15 minutes and it takes 2 minutes to resolve a false alarm, the probability of an unresolvable false alarm, occuring during a crisis which goes on for 30 days, is estimated at about 0.2%. If decision times drops to 6 minutes, the probability increases to over 50%.[7]

In her thesis, Marsh criticizes the Wallace/Sennott/Crissey model and develops her own. She estimates that if the US were to adopt a launch on warning policy, an accidental nuclear war could occur within one year. However, under the current policy, which requires warning signals from both satellite sensors and ground based radars, she estimates that it would take at least 20,000 years before we might expect an accidental nuclear war. In other words she finds that the probability of accidental nuclear war, under current policies, is vanishingly small.

ESCALATION

In addition to the danger of a strategic launch in response to unresolved false alarms, there is a more complex scenario: the escalation of local conflict, involving conventional weapons, to an all-out nuclear war between the superpowers. There are many ways such an escalation could come about. For exemple, Soviet and American forces patrol the Persian Gulf. An incident at sea during a time of international crisis could escalate to direct confrontation between the superpowers.

Another plausible scenario is escalation of a conventional war in Europe.[8] Tactical nuclear weapons are deployed close to the borders that would become the frontline in a European war, and field commanders would want to have control over the use of those installations. There would be intense pressure on political leaders to release the electronic codes that 'unlock' the permissive action links (PALs) described earlier, and to pre-delegate the authority to use those weapons. Under these circumstances, the 'nuclear threshold' could be easily crossed, especially if a commanding officer feared that those nuclear weapons might be captured or destroyed by opposing forces.

During any conflict involving the conventional forces of the US and the USSR, strategic nuclear systems would be on a high state of alert. This means that many of the 'safety catches,' the negative controls, would be taken off. As soon as nuclear weapons are used on the battelfield, the crisis would intensify. There would be growing pressure to respond rapidly to any sign that the other side might be preparing to launch a strategic attack. Indeed, there would be strong incentives on both sides to launch a pre-emptive strike against the strategic forces and the command and control centres of the adversary. The political and military calculation is simple: the damage suffered in a retaliatory strike would be less than the destruction resulting from a coordinated first strike by the enemy. The confusion, the intense pressure on decision-makers, and the elimination of peacetime safeguards would create the kind of momentum that leads to escalation.

RECOMMENDATIONS TO REDUCE THE RISKS

A purely accidental nuclear war seems unlikely under normal peacetime conditions. Standard nuclear operating procedures include a number of negative controls that work to prevent an accidental or unauthorized launch. Analysts warn, first and foremost, against the adoption of a launch on warning posture. While it is true that such a posture would increase the time between initial tactical warning and launch, giving precious time for consultation and decision-making, it would also greatly increase the risk of accidental nuclear war.

The models for assessing the risk of accidental nuclear war point to some fairly obvious policy

proposals. They indicate the need to prohibit forward-based systems which have very short flight times to military targets including command centres. The authors of those models can rejoice at the agreement to remove Pershing IIs and SS-20s from Europe. Concerns over naval forces remain but perhaps these will be addressed in negotiations on strategic forces.

Bruce Blair, in his book *Strategic Command and Control*, puts forward a series of recommendations. The first is to build a less vulnerable command and control system for strategic nuclear arsenals.[9] Blair's rationale is that greater confidence in the survivability of the command centres will reduce the incentives to respond rapidly to any warnings of attack, or worse, the urge to pre-empt if one side becomes convinced that an enemy attack is imminent.

Blair also argues that the current imperative to respond immediately to nuclear attack is an article of dogma that should be abandoned. His concern is that the severe time constraints and intense pressures preclude rational decision-making:

> Strategic organizations actually expect to receive retaliatory authorization within minutes after initial detection of missile launches. That expectation is so deeply ingrained that the nuclear decision process has been reduced to a drill-like enactment of a prepared script, a brief emergency telecommunication conference whose purpose is to get a decision from the national command authority before incoming weapons arrive.[10]

Instead Blair advocates a policy of 'no immediate second use;' the US should ride out a Soviet first strike and take as much time as is necessary to consider what response is appropriate. The emphasis would be on survivability of forces and the maintenance of strict negative control over all nuclear forces deployed around the world and at sea.

Tied into the requisite for survivability is a recommendation put forward by Blair and many others — the move away from a reliance on highly vulnerable land-based ballistic missiles. In the past, the argument for land-based forces hinged on their greater accuracy, a feature which makes them more effective against small, 'hardened' military targets. This argument has lost much of its force with the deployment of D-5 missiles on Trident submarines. These missiles carry warheads with accuracies approaching that of land-based systems, and submarines are much more survivable. The difficulty is that the Soviet Union has about two-third of its strategic warheads deployed on land-based missiles and has less access to open waters than does the United States. In addition, its submarine force is less sophisticated than that of the US. For these reasons, the Soviet Union has resisted the suggestion that it shift its strategic force structure away from a reliance on land-based systems to less vulnerable sea-based weapons.

As noted earlier, submarine launched missiles and other sea-based nuclear weapons are a worry to some analysts, partly because of the lack of restrictive controls and partly because of the stress under which the submarine crew lives. It has been recommended that permissive action links (PALs), similar to those on theatre nuclear weapons in Europe, be installed on all nuclear weapons at sea.[11] This would reduce the risk that naval tactical weapons or SLBMs could be launched without authorization. These restrictions do not, however, address the problems of stress which have been the subject of recent psychological studies.[12]

To reduce the danger of escalation from a conventional war in Europe, a number of suggestions have been put forward. Many of the roles assigned to tactical nuclear weapons in Europe could be covered by new conventional weapons and NATO could do away with nuclear landmines and nuclear artillery shells. There have also been calls for NATO to adopt a policy of 'no first use' or 'no early use' of nuclear weapons. These declaratory policies would of course have to be coupled with changes in force deployments and operational procedures which would reflect a reduced reliance on nuclear weapons. One manifestation of these changes would be a move away from the doctrine of pre-delegating, in times of crisis, the authority to use tactical nuclear weapons.

It has also been suggested that NATO and the Warsaw Pact pull back nuclear weapons which are deployed close to the borders in Central Europe. In 1982, the Palme Commission report proposed the creation of a corridor 300 kilometres wide overlapping the territories of West Germany, East Germany and Czechoslovakia.[13] All nuclear weapons would be removed from this corridor. The proposal had both military and political aims. It was argued that this nuclear free zone would raise the threshold between conventional and nuclear war in Europe and, during peacetime, would serve to reduce tensions between NATO and the Warsaw Pact. To date this proposal has received no official support in Western capitals.

Because the danger of war by accident or inadvertence is greatest during a time of severe international crisis, many of the recommendations for reducing the risk of war have to do with crisis prevention or 'crisis management.' In a paper entitled, "Nuclear Alerts and Crisis Management," Scott Sagan warns against putting nuclear-equipped forces on alert as a political signal to the adversary. He recounts incidents of civilian leaders ordering an increase in the alert status of US forces without a proper understanding of the implications.[14] When the adversary detects the heightened alert status, there is a danger that the crisis will escalate; one or both sides might lose control of the situation. The result could be an interlock-

ing cascade of moves and counter-moves similar to the 'precautionary' mobilizations of 1914.

The prevention of accidental or inadvertent war is a part of the common ground between the superpowers, and they have signed a number of agreements designed to reduce the risks. One of these was the Hotline agreement of 1963 which established direct teletype communications between Moscow and Washington. In 1984, the US and the USSR agreed to upgrade the Hotline by adding a facsimile transmitter. This equipment can scan a document and translate the print into signals which can be transmitted by telephone and reproduced as type at the other end.

The Accidental Measures Agreement of 1971 includes pledges by the US and USSR to notify one another of unauthorized use of nuclear weapons, of ambiguous warnings that threaten to lead to nuclear war, and of any test missile launches that go beyond the home territory of the country performing the tests. Under the Incidents at Sea Agreement of 1972, both sides pledge to avoid dangerous actions on the high seas, to adhere strictly to the 'Rules of the Road,' and not to simulate attacks on passing ships.

Two senators in the United States, Democrat Sam Nunn and Republican Jack Warner, have promoted the idea of jointly manned risk-reduction centres in the US and the Soviet Union. The purpose of these centres would be to deal with ambiguous warnings, acts of nuclear terrorism and other events that might trigger an accidental nuclear war. On 15 September 1987, Soviet Foreign Minister Eduard Shevardnadze and US Secretary of State George Schulz signed an agreement outlining some modest moves in this direction. Centres will be set up in both capitals to exchange information about upcoming missile launches, but they will not be jointly manned.

More generally, analysts are trying to suggest guidelines for crisis prevention and strategies for better management of the crises that do arise. In the excellent survey entitled *Hawks, Doves and Owls: An Agenda for Avoiding Nuclear War*, the editors suggest ways to better prepare civilian leaders for their crisis management role:

> Nuclear decision-makers often are not experts on the subject. Many new political appointees with responsibilities related to nuclear weapons arrive at their jobs with little knowledge or background in US-Soviet relations, nuclear weapons affairs, or crisis decision-making . . . it would be useful to offer some compilation of lessons learned from the experience of former officials in similar positions of responsibility. Active participation in crisis simulations can also be a valuable experience.[15]

CONCLUSION

The danger of accidental or inadvertent nuclear war is low during normal peacetime conditions but increases during times of crisis when positive control, the need to respond rapidly to an attack, is at odds with negative control — that is, the safeguards that prevent the unauthorized or accidental use of nuclear weapons. The trade-offs between positive and negative control will continue to pose problems in the future.

The risks should not be exaggerated but neither should they be ignored. Accidental nuclear war is a 'management' problem which requires careful analysis and ongoing efforts at prevention. Some weapons systems and some operational procedures increase the dangers but there are ways of reducing the risks and those are being explored.

This is an area where the interests of the two superpowers coincide and there are encouraging signs that the two will strive to find measures, both unilaterally and in concert, to reduce the risk.

NOTES

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